INDOOR AIR QUALITY ASSESSMENT

Massachusetts Department of Social Services
215 Hamilton Street
Leominster, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
September 2003

Background/Introduction

At the request of the Leominster Board of Health (LBOH), the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality concerns at the Massachusetts Department of Social Services (DSS), located at 215 Hamilton Street, Leominster, MA. Concerns about microbial growth in building materials resulting from water damage prompted the request.

On June 27, 2003, a visit to conduct an indoor air quality assessment was made to the DSS by Cory Holmes, an Environmental Analyst in BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) program. Ann Cramer and Michelle Powell, Code Enforcement Inspectors for the LBOH accompanied Mr. Holmes. Also present during the inspection was Chris Martell, Chief Union Steward representing DSS employees.

The DSS leases space in the southeast section of a one-story, aluminum sided building. The building was constructed as a warehouse that was converted to office space. Also located in the building are several other businesses including a gymnasium and a manufacturing plant that makes moldings/castes. No windows are openable throughout the DSS office space.

As a result of previous indoor air quality complaints, an indoor air quality study was conducted by the Massachusetts Division of Occupational Safety (MDOS), Occupational Hygiene/Indoor Air Quality Program, in September of 2002. The DOS issued an IAQ report, which recommended the following remedial actions:

1. Increase outdoor air intake to 15 - 25 percent;

2. Set ventilation fans to "on" to provide continuous outside air;
3. Install return air vents in offices;
4. Repair water leaks and replace water damaged ceiling tiles;
5. Consider reconfiguring supply vents in open areas to facilitate airflow; and
6. Develop an IAQ management plan (MDOS, 2002).

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. Water content of gypsum wallboard (GW) was measured with Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe.

Results

The DSS has an employee population of approximately 100 and is visited by approximately 20-30 individuals daily. The tests were taken during normal operations. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 ppm (parts per million) in two of thirty areas surveyed, indicating adequate ventilation in the majority of the building.

Fresh, heated air is supplied by four air-handling units (AHUs) located at ground level on the exterior of the building (see Picture 1). Ventilation is delivered to occupied areas via ceiling-mounted air diffusers connected to ductwork (see Picture 2). Return/exhaust air is drawn back to AHUs through ceiling grates connected to ductwork.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health

Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please refer to Appendix I.

Temperature readings ranged from 73^{o} F to 80^{o} F, which were within the BEHA recommended comfort guidelines in all but one area. The BEHA recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. The conference room (80^{o} F) was fully occupied for a training course during the assessment and was one of the two areas that had elevated carbon dioxide levels (1075 ppm). The elevated temperature and carbon dioxide may be an indication that that the conference room is exceeding its occupant capacity and/or the HVAC system needs to be adjusted. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The vent in Picture 3 was covered with plastic, presumably to minimize drafts. However, this alteration of the system can throw the system off-balance and create uneven heating/cooling conditions in other areas adjacent to the blocked diffuser.

The relative humidity measured in the building ranged from 51 to 63 percent, which was within the BEHA recommended comfort range. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

During the second week of June 2003, the building experienced water damage due to water infiltration along the southeast wall of the building. Carpeting and rubber baseboard coving in this area were removed, exposing a black substance on the walls interior that occupants believed to be microbial growth (see Picture 4). The most likely source of infiltration appears to be along the tarmac/exterior wall junction and around HVAC ductwork that traverses the exterior wall in this area. Rainwater appears to pool on the ground at the base of the building in this area as evidenced by water damage and moss growth at the base of the exterior wall (see Pictures 5 & 6). Moss growth is another indication of chronic moisture exposure from rainwater. Moss growth also holds moisture against brickwork. Excessive exposure to water can result in damage to building materials over time. During winter weather, the freezing and thawing of moisture can accelerate deterioration of cement, brick/mortar and other building materials. DSS officials reported that the building management had made repairs to the exterior of the building and that the leaks had not reoccurred. In addition, carpeting is installed directly on the cement floor with no backing or padding material, which allowed it to dry quickly.

In order for building materials to support mold growth, a source of water exposure is necessary. Identification and elimination of water moistening building materials is necessary to control mold growth. GW with increased moisture content over normal concentrations may indicate the possible presence of mold. Identification of the location of GW with increased moisture levels can also provide clues concerning the source of mold growth. In an effort to ascertain moisture content of GW, measurements were taken in areas directly impacted by water damage as well as a number of areas that appeared not to have been effected for comparison (Table 1). As previously mentioned, water content of GW was measured with a Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe. The probe was inserted into the surface of GW at various heights. The Delmhorst probe is equipped with three lights as visual aids to determine moisture level. Readings which activate the green light indicate a sufficiently dry moisture level (0 - 0.5%), those that activate the yellow light indicate borderline conditions (0.5 – 1.0%) and those that activate the red light indicate elevated moisture content (> 1%). No elevated moisture measurements were recorded. These results indicate that the building materials were not moistened at the time of this assessment and that microbial growth would be limited due to a lack of water. However, a dry dark substance, which appeared to be mold, was observed along the surface of GW where rubber coving was removed (see Picture 4).

Periodic leaks along the ceiling, associated with wind-driven rain, were reported in an area known as Mr. Perreault's office. BEHA staff removed ceiling tiles in this area to observe conditions in the ceiling plenum. No obvious signs of water damage, mold growth and/or associated odors were detected (see Picture 7). The most likely source of water leakage in this area is flashing around ductwork that enters the building directly outside of Mr. Perreault's office (see Picture 8).

Some areas had water coolers and/or water fountains installed over carpeting. Water spillage or overflow of cooler catch basins can result in the wetting of the carpet. Several of these water coolers had residue/build-up in the reservoir. These reservoirs are designed to catch excess water during operation and should be emptied/cleaned regularly to prevent microbial and/or bacterial growth.

Several areas had plants. Moistened plant soil and drip pans can serve as a source of mold growth. Plants should be equipped with drip pans and located away from the air stream of ventilation to prevent the aerosolization of dirt, pollen or mold.

Other Concerns

A number of other conditions were noted during the assessment, which can affect indoor air quality. Several ozone generating air purifiers were stationed on shelves throughout the building (see Picture 9). At this time, no federal government agency has approved the efficacy of ozone as an indoor air cleaner for use in occupied spaces. While ozone may be effective in removing some odors of biological original (i.e. skunk odors), its use as a universal air cleaner has come under question (USEPA, 2003). Ozone is a highly irritating substance to the respiratory system. Until more definitive information becomes available, ozone generators in occupied areas should be used with caution. In subsequent correspondence with the Leominster Health Department, it was reported that the ozone generators were removed from the building.

An air purifier was seen in one occupant's office. These units are normally equipped with filters, which should be cleaned or changed as per the manufacturer's instructions to avoid the build-up and re-aerosolization of dirt, dust and particulate matter.

Also of note was the amount of materials stored on flat surfaces throughout the space. In many areas, items were observed piled on windowsills, tabletops, counters, bookcases and desks. Accumulation of dust on flat surfaces was observed. Dust can be irritating to the eyes, nose and respiratory tract. The large amount of items stored provides a means for dusts, dirt and other potential respiratory irritants to accumulate. These stored items, (e.g. papers, folders, boxes) make it difficult for custodial staff to clean. A number of exhaust and return vents were also noted with accumulated dust. These vents should be cleaned periodically to avoid the re-aerosolization of dust and particulates.

A container of paint thinner dated 1967 and other products containing volatile organic compounds (VOCs) were observed on a wooden shelf in the storage room (see Picture 10). VOCs can be irritating to the eyes, nose and throat. Paint thinner is also a flammable material that should be kept in a flammable locker approved by the National Fire Prevention Agency (NFPA, 1996).

Several areas contain photocopiers. Ozone and VOCs can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, 1992). As previously mentioned, VOCs can be a source of irritation. Photocopiers should be located near local exhaust ventilation.

DSS staff frequently use a spray (3-M Office Cleaner) to clean personal work areas. This material contains VOCs (e.g. isopropyl alcohol and monoethanolamine) that can be irritating to the eyes, nose and throat (3M, 2000) (see Picture 11).

Several areas contained dry erase boards and dry erase markers. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999). Accumulated dry erase marker particulate was noted in several areas. This material is a fine particulate, which can be easily aerosolized and be a source of eye and respiratory irritation.

A number of ceiling tiles were reportedly changed throughout the office. The ceiling plenum is insulated with fiberglass insulation. The movement and replacement of ceiling tiles provide the opportunity for airborne dirt, dust and particulates to penetrate into occupied areas. Aerosolized dust, particulates and fiberglass can provide a source of eye, skin and respiratory irritation to certain individuals. These materials can accumulate on flat surfaces (e.g. desktops, shelving, carpets.) below these areas and subsequently be re-aerosolized causing further irritation. In addition, various objects were hung from the ceiling tile system in some areas of the DSS. As discussed, the movement of ceiling tiles can provide a pathway for particulates into occupied areas. Building occupants should refrain from hanging objects from ceiling tile system.

Finally, the dumpster is located at the front of the building in close proximity to one of the AHUs. Although no reports of trash odors were reported, the close proximity of the dumpster to the building may provide for nuisance odors to be entrained through the AHU fresh air intake (see Picture 12). Another potential source of odor entrainment is vehicle exhaust. Picture 12 also shows vehicles parked in close proximity to the AHU. Idling vehicles can result in the entrainment of vehicle exhaust into the building, which may, in turn, provide opportunities for exposure to compounds such as carbon monoxide. M.G.L. chapter 90 section 16A prohibits the unnecessary operation of the engine of a motor vehicle for a foreseeable time in excess of five minutes (MGL, 1996).

Conclusions/Recommendations

In view of the findings at the time of the assessment, the following recommendations are made:

1. Continue to implement recommendations provided by the MDOS (MDOS, 2002).
2. Remove water damaged carpeting and rubber baseboard coving in the general vicinity of water leakage and examine for fungal growth. Vacuum dry surface of floor and along base of GW with a HEPA filter equipped vacuum cleaner. Disinfect non-porous surfaces with clean with an appropriate microbiological agent.
3. Leave cement floor and walls exposed to ensure leaks have been repaired.
4. If more extensive water damage/mold growth is found, remove mold-contaminated materials in a manner consistent with recommendations found in "Mold Remediation in Schools and Commercial Buildings" published by the US Environmental Protection Agency (US EPA, 2001). Copies of this document can be downloaded from the US EPA website at: http://www.epa.gov/iaq/molds/mold_remediation.html
5. Continue to examine methods to eliminate water penetration into the building. Consider consulting a building engineer/building envelope specialist about possible

options to eliminate water penetration. Explore options for providing a water/vapor barrier between exterior walls and interior space. Work with building envelope specialists to make repairs/improve flashing to prevent further leaks.

6. Improve the grading of the ground away from the foundation at a rate of 6 inches per every 10 feet (Lstiburek, & Brennan, 2001).
7. Maximize air exchange by operating both supply and exhaust ventilation continuously during periods of building occupancy independent of thermostat control. Continue to set thermostats to fan "on" position to provide a constant source of ventilation.
8. Increase the percentage of fresh air supply into the HVAC system in some areas (e.g. the conference room, kitchen) as a means to improve indoor air quality. Consult with a ventilation engineer to determine methods to increase fresh air intake.
9. Remove blockages from air diffusers (i.e. plastic) to facilitate airflow. Consider reconfiguring office space or replacing air diffuser with an alternative design to improve occupant comfort.
10. Balance mechanical ventilation systems every five years, as recommended by ventilation industrial standards (SMACNA, 1994). Consult a ventilation engineer concerning re-balancing of the ventilation systems.
11. Clean/change filters for air-handling equipment as per the manufacturer's instructions or more frequently if needed.
12. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a HEPA filter equipped

vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

13. Work with a roofing contractor to identify and repair leaks. Replace any water-stained ceiling tiles and building materials. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
14. Ensure drip pans are placed underneath plants. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary.
15. Relocate or place tile or rubber matting underneath water coolers in carpeted areas.
16. Discard hazardous materials (paint thinner) or empty containers of hazardous materials in a manner consistent with environmental statutes and regulations. Follow proper procedures for storing and securing hazardous materials. Obtain Material Safety Data Sheets (MSDS') for chemicals from manufacturers or suppliers.
17. Consider discontinuing the use of VOC-containing cleaners. Less irritating materials (e.g. soap and water) may suffice to clean occupant areas.
18. Clean/change filters in portable air purifier as per the manufacture's instructions or more frequently if needed.
19. Clean dry erase board trays regularly to avoid the build-up of particulates.
20. Refrain from hanging objects from ceiling tile system.
21. Conduct work above ceiling tiles during unoccupied periods or periods of low occupancy. Inform employees in advance in order to remove cluttered items and/or to cover work area to ease cleaning. Once work is completed wet wipe and/or vacuum

area with a HEPA filtered vacuum cleaner to clean up all residual dirt, dust and particulates.

22. Consider relocating the dumpster away from the AHU as a means to minimizing/ preventing odor entrainment.

23. Consider prohibiting parking in the general areas of the AHU to minimize/prevent vehicle exhaust entrainment. If not, feasible consider posting signs instructing occupants/visitors not to back into parking spots.

24. For further building-wide evaluations and advice on maintaining public buildings, see the resource manual and other related indoor air quality documents located on the MDPH's website at http://www.state.ma.us/dph/beha/iaq/iaqhome.htm.

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Picture 1

Typical AHU for DSS Office Space

Picture 2

Ceiling-Mounted Air Diffuser

Picture 3

Fresh Air Supply Diffuser Covered With Plastic

Picture 4

Occupied Area Where Water Damage Occurred, Note Dark Staining on Floor and Base of Wall

Picture 5

Water Damaged Exterior Wall Material and Moss Growth along Southeast Side of Building Where Water Infiltration Occurred

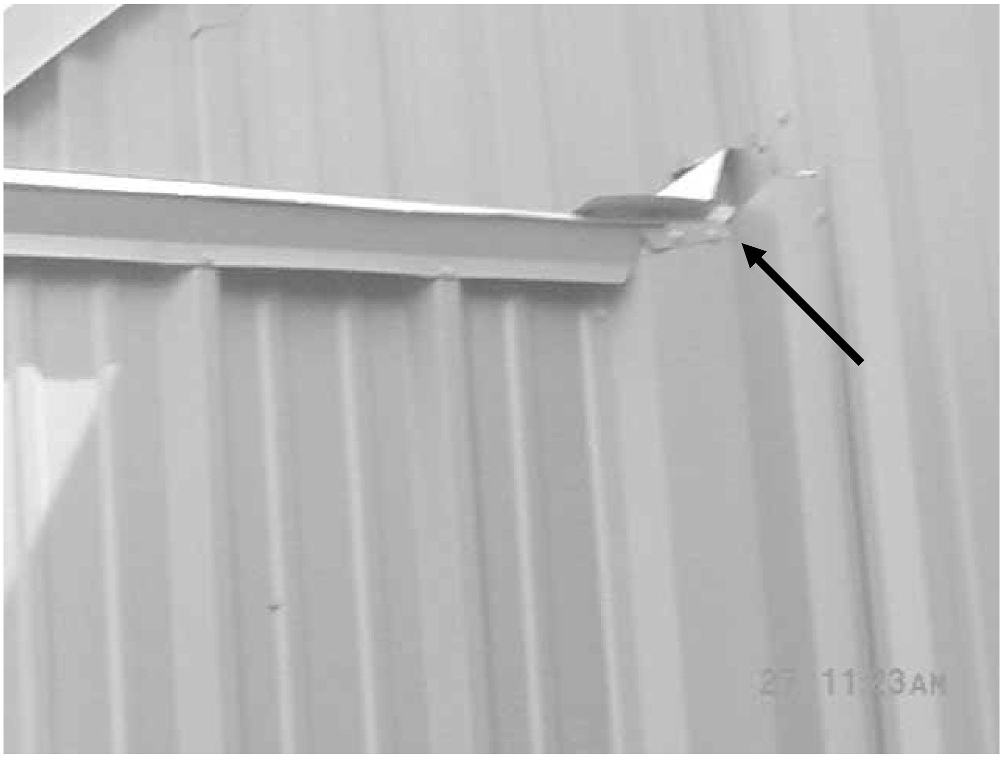
Picture 6

Water Damaged Exterior Wall Material and Moss Growth along Southeast Side of Building Where Water Infiltration Occurred

Picture 7

Rubber Coving Removed in Mr. Perrault's Office, No Signs of Water Damage/Mold Growth

Picture 8



Aluminum Flashing Around Ductwork

Picture 9

Ozone Generator (One of Six)

Picture 10

Paint Thinner (dated 1967) and other VOC-Containing Materials on Wooden Shelf in Storage Room

Picture 11

Front View of 215 Hamilton Street Illustrating the Proximity of The Dumpster and Parked Vehicles to the AHU, Note Second Car in is Backed into its Spot

TABLE 1

Indoor Air Test Results –Dept. of Social Services, Leominster, Massachusetts June 27, 2003

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Background	395	92	78					Hot humid, clear skies
Conference Room	1075	80	53	20	N	Y	Y	Portable fans, dry erase boards
Perimeter of Building								Flaking of cement coating ext wall Moss growth So. East side, water damage (accumulation)
Reception	705	77	51	1	N	Y	N	Portable fan on
Photocopier Room	737	76	52	1	N	Y	N	Photocopier
Storage Room	716	76	61	0	N	Y	N	Paint thinner (1967) on wooden shelf
Prostak	770	76	60	3		Y	Y	Plants
Mastromatto	758	76	62	1	N	Y	N	
Intake Unit	762	77	61	3	N	Y	Y	
Marrell	675	77	60	2	N	Y	Y	Items hanging from CTs Plants – fan

*** ppm = parts per million parts of air**
WD – water damaged

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred 600 - 800 ppm = acceptable > 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 1

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						Supply	Exhaust	
Dunn	727	76	63	1	N	Y	N	Plants
Marino	709	76	62	1	N	Y	N	
Reeves	748	76	62	2		Y	Y	Plants
Graves	668	76	60	0		Y	Y	Exposed fiberglass
Mainsuy	753	76	58	2		Y	N	Fish bowl-cloudy
Reeves	733	75	57	1		Y	Y	Dry erase board particulate build-up in tray
Hartman	701	74	58	0		Y	N	WD paint, GW 0.4 (dry)
Doiron (Kinship Area)	707	74	60	0		Y	N	Carpet dry, visible mold growth on back of rubber coving, no backing/padding carpet-cement floor, GW 0.2-0.4 (dry)
Intake Unit B	720	74	61	2	N	Y	N	
Adoption Unit	740	74	60	5	N	Y	N	

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Ongoing Unit B	698	74	61	3	N	Y	N	Plants
Family Resource Unit	757	74	59	2	N	Y	N	Water cooler on carpet Standing water reservoir
Griffen	692	73	58	1	N	Y	N	
Van Kennen	699	74	59	0	N	Y	N	
Callahan	725	74	60	1	N	Y	Y	
Ongoing Protective Unit	695	75	61	3	N	Y	N	
Perreault	765	74	58	1	N	Y	N	Periodic leaks near ceiling Carpet dry, wall cavity dry, GW 0.2-0.4 (dry)
Case File Room	643	73	57	0	N	Y	N	Plastic odors from binders No exhaust
Adolescent Workers	643	74	60	3	N	Y	Y	3M – Office cleaner, spray eye irritant
Alden	670	73	58	0	N	Y	N	

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						Supply	Exhaust	
Kitchen	803	76	58	4	N	Y	Y	
Cleaning Unit	712	76	56	2	N	Y	Y	Nasal, headaches, congestion complaints

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